

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

Applicant(s): Borden, et al.
Assignee: Boxer Cross, Inc.
Title: IDENTIFYING DEFECTS IN A CONDUCTIVE STRUCTURE OF A
WAFER, BASED ON HEAT TRANSFER THERETHROUGH
Serial No.: Unknown Filing Date: Herewith
Examiner: Unknown Group Art Unit: Unknown
Docket No.: M-12169 US

San Jose, California
March 1, 2002

BOX Patent Application
COMMISSIONER FOR PATENTS
Washington, D. C. 20231

PRELIMINARY AMENDMENT

Dear Sir:

Please amend the above-identified patent application as follows (a version with markings to show changes made appears at the end):

IN THE CLAIMS

1. (Unchanged) A method of identifying a defect in a semiconductor wafer, the method comprising:
applying heat to a conductive structure formed on said semiconductor wafer;
measuring a signal indicative of temperature of a portion of the conductive structure heated by conduction of the applied heat therethrough, thereby to obtain a measurement;
repeating the act of measuring at each of a number of different locations on the conductive structure, thereby to obtain a plurality of measurements; and
determining presence of the defect in the conductive structure, depending on the plurality of measurements.

LAW OFFICES OF
SKJERVEN MORRILL
MACPHERSON LLP

25 METRO DRIVE
SUITE 700
SAN JOSE, CA 95110
(408) 453-9200
FAX (408) 453-7979

2. (Unchanged) The method of Claim 1, wherein:
a laser beam is used during said applying of heat;
reflection of another laser beam is measured during said
measuring; and
the laser beams are scanned together during said
measuring.
3. (Unchanged) The method of Claim 2, wherein:
the laser beams are coincident, thereby to form a single
spot on the conductive structure.
4. (Unchanged) The method of Claim 1, wherein:
the conductive structure has at least one dimension less
than 1 μm .
5. (Unchanged) The method of Claim 1, wherein:
an electron beam is used during said applying of heat.
6. (Unchanged) The method of Claim 1, wherein:
a thermal imager is used during said measuring.
7. (Unchanged) The method of Claim 1, wherein:
said conductive structure is periodic in space along a
direction, and said locations are along said direction.
8. (Unchanged) The method of Claim 7, wherein:
said determining includes using a transform of said
plurality of measurements, said transform converting said
plurality of measurements from a spatial domain into a
frequency domain.
9. (Unchanged) The method of Claim 7, wherein:

LAW OFFICES OF
SKJERVEN MORRILL
MACPHERSON LLP

25 METRO DRIVE
SUITE 700
SAN JOSE, CA 95110
(408) 453-9200
FAX (408) 453-7979

said determining includes identifying a frequency component not found in a corresponding plurality of measurements from a reference wafer.

10. (Unchanged) The method of Claim 7, wherein:

said determining includes comparing a curve defined by said plurality of measurements to a reference curve defined by a corresponding plurality of measurements from a reference wafer.

11. (Unchanged) The method of Claim 7, wherein:

said determining includes comparing a curve defined by said plurality of measurements to a baseline.

12. (Unchanged) The method of Claim 7, wherein:

a measurement is performed at least at a plurality of vias located sequentially one after another in said direction.

13. (Unchanged) The method of Claim 7, wherein:

a pump beam is incident on a first trace in the conductive structure during said applying; and

a probe beam is incident on a second trace in said conductive structure during said measuring; and

wherein said first trace is coupled to said second trace through at least one via.

14. (Unchanged) The method of Claim 11 wherein:

each of said first trace and said second trace are in a single metal layer.

15. (Unchanged) The method of Claim 11, wherein:

each of said first trace and said second trace are in different metal layers.

LAW OFFICES OF
SKJERVEN MORRILL
MACPHERSON LLP

25 METRO DRIVE
SUITE 700
SAN JOSE, CA 95110
(408) 453-9200
FAX (408) 453-7979

[illegible][illegible][illegible][illegible][illegible][illegible][illegible][illegible][illegible][illegible][illegible][illegible]

22. (Unchanged) A method for determining the quality of a conductive structure, the method comprising:

applying heat to the conductive structure using a modulated heat source;

varying the frequency of modulation of said heat source;

measuring a change in temperature of said conductive structure, as a function of the frequency of modulation; and

analyzing said function to determine the quality of said conductive structure.

23. (Unchanged) The method of Claim 22, wherein reflection of a laser beam is used to measure the temperature change.

24. (Unchanged) The method of Claim 22, wherein heat is applied to said conductive structure using a laser beam.

25. (Unchanged) The method of Claim 22 further comprising:

repeating the act of measuring at each of a number of different locations on the conductive structure, thereby to obtain a plurality of measurements; and

using said plurality of measurements during said analyzing.

26. (Unchanged) The method of Claim 22 further comprising:

moving a stage carrying a semiconductor wafer containing the conductive structure at a fixed speed; and

performing said act of measuring continuously, thereby to obtain an analog signal; and

using said analog signal during said analyzing.

27. (Unchanged) The method of Claim 22 wherein said analyzing comprises:

identifying irregular features in the conductive structure.

- 201010 28206001
28. (Amended) An apparatus for identifying a defect in a conductive structure, the apparatus comprising:
- a laser for applying heat to the conductive structure;
 - a sensor for measuring a signal indicative of temperature of a portion of the conductive structure heated by conduction of the applied heat therethrough; and
 - means for determining presence of the defect in the conductive structure, based on the measured temperature.
29. (Amended) The apparatus of Claim 28, wherein said sensor for measuring comprises a thermal imager.
30. (Amended) The apparatus of Claim 28 wherein said means for determining comprises a personal computer.

LAW OFFICES OF
SKJERVEN MORRILL
MACPHERSON LLP

25 METRO DRIVE
SUITE 700
SAN JOSE, CA 95110
(408) 453-9200
FAX (408) 453-7979

REMARKS

The last three claims are renumbered because the original application has two claims numbered as 27.

In addition, the claim now numbered as 28 is amended to correct a typographical error ("the sensor" is change to --a sensor--).

EXPRESS MAIL LABEL NO:

EL 937 083 135 US

Respectfully submitted,

Michael Shunker
Reg. No. 34,250

for Omkar K. Suryadevara
Attorney for Applicant(s)
Reg. No. 36,320

LAW OFFICES OF
SKJERVEN MORRILL
MACPHERSON LLP

25 METRO DRIVE
SUITE 700
SAN JOSE, CA 95110
(408) 453-9200
FAX (408) 453-7979

Version with markings to show changes made

1. (Unchanged) A method of identifying a defect in a semiconductor wafer, the method comprising:
- applying heat to a conductive structure formed on said semiconductor wafer;
 - measuring a signal indicative of temperature of a portion of the conductive structure heated by conduction of the applied heat therethrough, thereby to obtain a measurement;
 - repeating the act of measuring at each of a number of different locations on the conductive structure, thereby to obtain a plurality of measurements; and
 - determining presence of the defect in the conductive structure, depending on the plurality of measurements.
2. (Unchanged) The method of Claim 1, wherein:
- a laser beam is used during said applying of heat;
 - reflection of another laser beam is measured during said measuring; and
 - the laser beams are scanned together during said measuring.
3. (Unchanged) The method of Claim 2, wherein:
- the laser beams are coincident, thereby to form a single spot on the conductive structure.
4. (Unchanged) The method of Claim 1, wherein:
- the conductive structure has at least one dimension less than 1 μm .
5. (Unchanged) The method of Claim 1, wherein:
- an electron beam is used during said applying of heat.
6. (Unchanged) The method of Claim 1, wherein:

LAW OFFICES OF
SKJERVEN MORRILL
MACPHERSON LLP

25 METRO DRIVE
SUITE 700
SAN JOSE, CA 95110
(408) 453-9200
FAX (408) 453-7979

a thermal imager is used during said measuring.

7. (Unchanged) The method of Claim 1, wherein:

said conductive structure is periodic in space along a direction, and said locations are along said direction.

8. (Unchanged) The method of Claim 7, wherein:

said determining includes using a transform of said plurality of measurements, said transform converting said plurality of measurements from a spatial domain into a frequency domain.

9. (Unchanged) The method of Claim 7, wherein:

said determining includes identifying a frequency component not found in a corresponding plurality of measurements from a reference wafer.

10. (Unchanged) The method of Claim 7, wherein:

said determining includes comparing a curve defined by said plurality of measurements to a reference curve defined by a corresponding plurality of measurements from a reference wafer.

11. (Unchanged) The method of Claim 7, wherein:

said determining includes comparing a curve defined by said plurality of measurements to a baseline.

12. (Unchanged) The method of Claim 7, wherein:

a measurement is performed at least at a plurality of vias located sequentially one after another in said direction.

13. (Unchanged) The method of Claim 7, wherein:

a pump beam is incident on a first trace in the conductive structure during said applying; and

a probe beam is incident on a second trace in said conductive structure during said measuring; and

wherein said first trace is coupled to said second trace through at least one via.

14. (Unchanged) The method of Claim 11 wherein:

each of said first trace and said second trace are in a single metal layer.

15. (Unchanged) The method of Claim 11, wherein:

each of said first trace and said second trace are in different metal layers.

16. (Unchanged) The method of Claim 1, wherein:

said determining includes comparing the plurality of measurements to a corresponding plurality of measurements obtained from a reference wafer.

17. (Unchanged) The method of Claim 1, wherein:

said repeated acts of measuring are performed while moving a stage carrying the semiconductor wafer containing the conductive structure; and

performing said measuring continuously, thereby to obtain an analog signal; and

using said analog signal during said determining.

18. (Unchanged) A method for determining the quality of a conductive structure, the method comprising:

applying heat to the conductive structure using a modulated heat source;

measuring a phase difference between temperature change of said conductive structure and modulation of said heat source; and

LAW OFFICES OF
SKJERVEN MORRILL
MACPHERSON LLP

25 METRO DRIVE
SUITE 700
SAN JOSE, CA 95110
(408) 453-9200
FAX (408) 453-7979

analyzing said phase difference to determine quality of said conductive structure.

19. (Unchanged) The method of Claim 18 wherein reflection of a laser beam is used to measure the phase difference.

20. (Unchanged) The method of claim 18 wherein said quality is related to a defect in said conductive structure.

21. (Unchanged) The method of Claim 20 wherein said defect is any defect in a group consisting of voiding, narrow trace, and misalignment of a via to a trace.

22. (Unchanged) A method for determining the quality of a conductive structure, the method comprising:

applying heat to the conductive structure using a modulated heat source;

varying the frequency of modulation of said heat source; measuring a change in temperature of said conductive structure, as a function of the frequency of modulation; and

analyzing said function to determine the quality of said conductive structure.

23. (Unchanged) The method of Claim 22, wherein reflection of a laser beam is used to measure the temperature change.

24. (Unchanged) The method of Claim 22, wherein heat is applied to said conductive structure using a laser beam.

25. (Unchanged) The method of Claim 22 further comprising:

repeating the act of measuring at each of a number of different locations on the conductive structure, thereby to obtain a plurality of measurements; and

LAW OFFICES OF
SKJERVEN MORRILL
MACPHERSON LLP

25 METRO DRIVE
SUITE 700
SAN JOSE, CA 95110
(408) 453-9200
FAX (408) 453-7979

using said plurality of measurements during said analyzing.

26. (Unchanged) The method of Claim 22 further comprising:
moving a stage carrying a semiconductor wafer containing the conductive structure at a fixed speed; and
performing said act of measuring continuously, thereby to obtain an analog signal; and
using said analog signal during said analyzing.

27. (Unchanged) The method of Claim 22 wherein said analyzing comprises:
identifying irregular features in the conductive structure.

27 28. (Amended) An apparatus for identifying a defect in a conductive structure, the apparatus comprising:
a laser for applying heat to the conductive structure;
the a sensor for measuring a signal indicative of temperature of a portion of the conductive structure heated by conduction of the applied heat therethrough; and
means for determining presence of the defect in the conductive structure, based on the measured temperature.

28 29. (Amended) The apparatus of Claim 27 28, wherein said sensor for measuring comprises a thermal imager.

29 30. (Amended) The apparatus of Claim 27 28 wherein said means for determining comprises a personal computer.

LAW OFFICES OF
SKJERVEN MORRILL
MACPHERSON LLP

25 METRO DRIVE
SUITE 700
SAN JOSE, CA 95110
(408) 453-9200
FAX (408) 453-7979